

**SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**  
**ENGINEERING AND COMPLIANCE DIVISION**  
*REFINERY & WASTE MANAGEMENT*

**ENGINEERING EVALUATION REPORT**

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Reviewed by	
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**FLARE MONITORING AND RECORDING PLAN**

**Facility Information**

**AIR LIQUIDE LARGE INDUSTRIES U.S., LP**  
**ID# 148236**  
**TITLE V: YES**  
**RECLAIM: NOX, SOX**  
**ZONE: COASTAL**  
**CYCLE: 1**

**Mailing Address**

**324 WEST EL SEGUNDO BLVD.**  
**EL SEGUNDO, CA 90245**

**Equipment Address**

**324 WEST EL SEGUNDO BLVD.**  
**EL SEGUNDO, CA 90245**

**Contact Information**

**MUKESH BHATT (ENVIRONMENTAL ENGINEER)**  
**(713) 624-8775**

**BACKGROUND:**

Air Liquide Large Industries US, LP operates a Hydrogen (H<sub>2</sub>) production plant inside the Chevron El Segundo Refinery that produces 99+ % pure H<sub>2</sub> for use in various hydroprocessing units within the El Segundo refinery. The plant, known as the 'Air Liquide Hydrogen Plant' (herein referenced as 'The Hydrogen Plant'), has the capability of producing up to 90 MMSCFD of 'pure' H<sub>2</sub> gas.

The Hydrogen Plant operates one (1) 'ground' flare that is subjected to the provisions and requirements of District Rule 1118. This ground flare (C4007) was put in service on October 11, 2005 to control CO emissions during planned startups, shutdowns, and emergency/process upset conditions in response to Order for Abatement No. 831-323. Unlike flare systems typical at other Hydrogen production facilities, C4007 only combust vent gases from process equipment downstream of the plant's reaction section (post medium shift reactor, V-105) and also from two safety relief valves (PRV) for the natural gas surge drums (V-201 and V-202) that feed the flare pilots. All other vent sources upstream of the reaction section (pre Pressure Swing Adsorption (PSA) unit) are routed to the Isomax flare inside the El Segundo refinery. The Isomax flare is owned and operated by Chevron and is included in Chevron's Rule 1118 plan.

C4007 is classified as a 'Clean Service' flare. It is designed and operated to combust vent gas with relatively fixed composition from specific equipment as defined in Rule 1118(b)(1). The vent gas composition to C4007 is relatively stable and contains very little (of commercial natural gas at worst) to no sulfur content (see Flare Process Description, Table 2 below). CEMS data has demonstrated that the worst case vent stream (natural gas) to average ~10 ppmv H<sub>2</sub>S.

The District amended Rule 1118 on November 4, 2005 in an effort to further reduce flare emissions. In order to better quantify flare emissions to meet the more stringent standards for SO<sub>x</sub> emissions, stricter control in monitoring and recording of flare activities was imposed in this latest Rule 1118 amendment. Reliable and accurate flare emissions data are crucial in ensuring petroleum refineries do not exceed their annual SO<sub>x</sub> emissions performance targets discussed in section (d) of Rule 1118. A revised Flare Monitoring and Recording Plan was required to be submitted to the District by 6-30-

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06 pursuant to Rule 1118(f)(1)(A) for approval. The Hydrogen Plant submitted this Flare Monitoring and Recording Plan on 7-31-06 under A/N 459313 for approval. No previous flare plan has been submitted by Air Liquide.

### **FLARE OVERVIEW**

The plant provides the following information on C4007:

Table 1 - Flare Information

Flare Device ID	Manufacturer/ Model	Type of Service	Pilots	Pilot Gas	Stages / Burners	Purge Gas	Vent Gases	Vent Gas Recovery
C4007	Callidus	Clean	5	Nat Gas	2 / 24 (total) 1 <sup>st</sup> stage with 4 burners 2 <sup>nd</sup> stage with 20 burners	N <sub>2</sub>	N <sub>2</sub> , H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , H <sub>2</sub> S (10 ppmv)	None

The flare system uses inert Nitrogen as the purge gas to prevent combustible mixtures from air infiltration into the burner piping system. No emissions are associated with using N<sub>2</sub> as the purge gas.

### **FLARE OPERATIONS & STAGING DESIGN**

The flaring operation of C4007 is divided into two (2) burner stages with a total of 24 burners. The first stage consists of 4 burners designed for a flare gas flow rate of 1.2 MMSCFH. The second stage consists of 20 burners designed for a flare gas flow rate of 4.7 MMSCFH. The maximum capacity of the flare is 5.9 MMSCFH.

Flare emissions are calculated using staging valve, XV-104, as an on/off flow indicator to the second stage. Flow is determined based on the maximum design capacity of the two stages and valve position of XV-104. When the plant's DCS indicate flare gas is being vented and XV-104 is closed, the flow rate is conservatively assumed to be 1.2 MMSCFH (maximum capacity of the 1<sup>st</sup> stage). The staging valve will remain closed until the vent gas flow rate exceeds 1.2 MMSCFH. When XV-104 is opened, the flow rate is conservatively estimated to be 5.9 MMSCFH (total flare capacity). The on/off position of XV-104 is continuously monitored and recorded in the plant's DCS. See Table 4 of the proposed plan for a summary of this staging logic.

### **PILOT OPERATIONS**

Five (5) continuous burning pilots, using commercial pipeline natural gas from the Gas Company, are used to ignite the gases vented to C4007. The pilots are mounted on a thermocouple for flame detection and the auto ignition system will re-ignite the pilot in the event the pilot is extinguished.

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The natural gas usage for the pilots will be based on the maximum design flow capacity of 0.3667 SCFM per pilot (1.833 SCFM total).

Rule 1118(g)(8)(C) exempts Clean Service flares from measuring and recording actual gas flow to the flare pilots. Hence, flare emissions from the pilots will be based on the maximum design capacity of 1.833 SCFM.

**FLARE PROCESS DESCRIPTION**

The three categories of vent gases (Syngas, PSA Offgas, and natural gas) combusted by C4007 are summarized in Table 2 below. The composition of Syngas and PSA Offgas is fairly consistent and is summarized in Section 1 of the Flare Monitoring and Recording Plan. Attachment 10 of the flare plan shows the gas composition, HHV, and sulfur content of Syngas and PSA Offgas combusted in C4007. The composition of commercial natural gas (regulated by the California PUC) is also fairly constant and a higher heating value (HHV) of 1060 BTU/Scf will be used for emissions calculation.

Table 2 – Vent Gases to C4007

Vent Gas Stream	Valve No.	Vent Source	Gas Composition	HHV, Btu/Scf
Syngas	PV-2233	Flow Control Valve for diverting Syngas to flare during startups, shutdowns, and process upsets.	H <sub>2</sub> , CO, CO <sub>2</sub> , CH <sub>4</sub> , trace N <sub>2</sub> , Sulfur-free	302
PSA Offgas	PV-2242	Flow Control Valve for diverting PSA Offgas to flare during startups, shutdowns, and process upsets.	H <sub>2</sub> , CO <sub>2</sub> , CO, CH <sub>4</sub> , trace N <sub>2</sub> , Sulfur-free	269
	PSV-6115A	Pressure Safety Valve for PSA Offgas drum to Reformer heater. PI-2242 monitors drum pressure and PSVs are set to relief to flare at 60 psig (typically operated at 5 psig)	H <sub>2</sub> , CO <sub>2</sub> , CO, CH <sub>4</sub> , trace N <sub>2</sub> , Sulfur-free	269
	PSV-6115B			
Natural Gas	PSV-0241	Pressure Safety Valve for natural gas surge drums (V-201/V-202) to flare pilots. PI-1511 monitors drum pressure and PSVs are set to relief to flare at 200 psig (typically operated at 160 psig).	CH <sub>4</sub> (> 90 mole %), H <sub>2</sub> , CO <sub>2</sub> , N <sub>2</sub> , C <sub>2</sub> H <sub>6</sub> - C <sub>5</sub> H <sub>12</sub> , H <sub>2</sub> S (10 ppmv max)	1060
	PSV-0242			

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Vent gas flow to the flare is indicated by the position of flow control valves PV-2233/PV-2242 and the pressure of the vessels protected by the four PSVs connected to the flare. The vent gas flow rate is conservatively estimated based on the on/off position of the flare staging valve, XV-104, as discussed earlier.

The flare staging valve, flow control valves, and pressure safety valves are all continuously monitored and recorded in the plant's DCS. Flare emissions can be calculated by using the appropriate emission factors (in lb/mm scf) for the vent stream, the flare gas flow rate (from on/off position of XV-104), and the flare event duration.

A detailed discussion on emission factors for these source specific streams can be found in section 3.3.3 of the proposed plan and is summarized in Table 3 below. These emission factors are based on Rule 1118 default factors adjusted to accommodate the unique characteristics of Syngas, PSA Offgas, and on performance data provided by the flare vendor (see Attachment 8, 9 and 10 of proposed plan).

Table 3 - Emission Factors for C4007 Flare Gases

Pollutant	Emission Factors, lb/mm scf		
	Syngas	PSA Offgas	Worst Case
ROG	0.46	1.26	<b>1.26</b>
PM	0.49	1.35	<b>1.35</b>
SO <sub>x</sub>	0.00	0.00	<b>0.00</b>
NO <sub>x</sub>	20.54	18.29	<b>20.54</b>
CO	17.12	47.16	<b>47.16</b>

The emission factors for Syngas and PSA Offgas are different because both have different heating values and compositions. The plant will use the above 'worst case' emission factors to calculate flare emissions when the natural gas surge drum pressure (monitored by PI-1511) is operating below 200 psig. When the surge drum pressure is above 200 psig (PSV-0241/PSV-0242 open and venting to flare header), emission factors for natural gas (see Rule 1118, Attachment B) will be used to calculate flare emissions regardless of the type of gas being vented.

The pilot, purge gas, and visible emissions monitoring methods are summarized in Table 4 below.

TABLE 4: Pilot, Purge Gas and Visible Emissions Monitoring Methods

Flare ID	Pilot Gas Flow	Purge Gas Flow	Pilot Flame	Visible Emissions
C4007	Actual set operating flow rate of 1.466 scfm. Maximum design flow rate is 1.833 scfm.	Nitrogen Gas not measured. No emissions since gas is inert	Thermo-Couple w/ Auto Ignite	Color Video Monitor

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**PLAN EVALUATION**

A Flare Monitoring and Recording Plan shall contain, at minimum, all the information specified by Subsections (f)(3)(A) through (f)(3)(Q) of Rule 1118. As shown in Table 5, Air Liquide's proposed plan meets the requirement specified in Section (f)(3) of the rule.

TABLE 5: Checklist for a Revised Flare Monitoring and Recording Plan

Requirements	Rule 1118 (f)(3)	Yes	Comment
A facility plot plan showing locations of flares	(A)	√	See Attachment 3 of the proposed plan
Flare information: (1) type of service (2) design capacity (3) operation and maintenance	(B)	√ √ √	See Sections 2.2.6, 2.2.2, and 2.2.3 of the proposed plan
Pilot and purge gas information: (1) type of gas used (2) actual set operating flow rate (3) Expected maximum total sulfur content (4) Expected average higher heating value	(C)	√ √ √ √	See Section 2.2.4 of the proposed plan
As-built process flow diagrams and drawings identifying flare header, flare stack, flare tip/burners, purge gas system, pilot gas system, ignition system, assist system, knockout drum, water and molecular seal, etc...	(D)	√	See Attachments 1, 4, 5 and 6 of the proposed plan
Flow diagrams showing the interconnections of the flares to vapor recovery system and process unit.	(E)	√	No vapor recovery system. See Attachments 6 and 7 for interconnections to process units
Descriptions of the assist system process control, flame detection system and pilot ignition system.	(F)	√	See Sections 2.1.3 and 2.2.5 of the proposed plan
Description of the gas flaring process if an integrated gas flaring system is being operated.	(G)	—	Not an integrated flare system
Description of the vapor recovery system: (1) type of compressor (2) design capacity of each compressor (3) design capacity of vapor recovery system (4) method to record amount of vapors recovered	(H)	— — — —	Not equipped with vapor recovery system.

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Requirements	Rule 1118 (f)(3)	Yes	Comment
Drawings with dimension showing: (1) location of sampling equipment (2) locations of HHV, TS analyzers (3) location of flow meter (4) location of on/off indicator	(I)	-- -- -- √	See Attachments 6 and 7 for location of on/off flow indicator. No flow meter, HHV, TS analyzers and sampling equipment used for this clean service flare. Values are calculated or based on design.
Manufacturer's specifications for existing and proposed flow meters and on/off flow indicator, HHV and TS analyzers: (1) make, model and type (2) range, precision and accuracy (3) calibration, maintenance and quality assurance procedures	(J)	√ √ √	See Table 3, Section 3.2.1 of proposed plan for on/off flow indicator. No HHV or total sulfur analyzers used. Values are calculated based on flare gas composition
Description and data used to determine actuating and de-actuating settings for on/off flow indicator , and method to verify these settings.	(K)	√	See section 3.2.2 of proposed plan.
Description of analytical and sampling methods or estimation method, if applicable, to determine high heating value and total sulfur content of vent gases.	(L)	√	See Sections 3.1 and Attachment 10 of proposed plan.
Description of data recording, collection and management system.	(M)	√	See Section 3.2.3 of proposed plan
Description of proposed method to determine, monitor and record total gas volume, HHV and total sulfur concentrations of vent gases.	(N)	√	Based on staging valve XV-104 and design capacity for each stage and event duration. Monitored and recorded in DCS. HHV and TS based on flare gas composition.
Schedule for installation and operation of flare monitoring system	(O)	--	Infrastructure & equipment in place for monitoring and recording flare emissions.
Description of any proposed alternative criteria to determine a sampling event for each specific flare.	(P)	--	None proposed.

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Requirements	Rule 1118 (f)(3)	Yes	Comment
A request to use an alternative sampling program pursuant to paragraph (g)(4)(C)	(Q)	√	See section 3.3.4 of proposed plan.

**RECOMMENDATION:**

Approve Air Liquide's Flare Monitoring and Recording Plan with the following conditions:

1. The owner/operator shall perform monitoring and recording of the operating parameters for the flare in accordance with this approved compliance plan and other applicable requirements of Rule 1118(g). Monitoring and recording of the below flare pursuant to this approved plan shall be performed at all times, except when out of service for reasons described in Rule 1118(g)(5)(A).

Flare Device ID	Type of Service
C4007	Clean

2. A flare event occurs when any one of the following conditions are met:
  - a. Flow control valve PV-2233 is open greater than one percent
  - b. Flow control valve PV-2242 is open greater than one percent
  - c. Vessel pressure (NG surge drum) monitored by PI-1511 is greater than 200 psig
  - d. Vessel pressure (PSA offgas drum) monitored by PI-2242 is greater than 60 psig

A flare event ends when all of the following conditions are met:

- a. Flow control valve PV-2233 is fully closed
  - b. Flow control valve PV-2242 is fully closed
  - c. Vessel pressure monitored by PI-1511 is less than or equal to 200 psig
  - d. Vessel pressure monitored by PI-2242 is less than or equal to 60 psig
3. A flare event lasting 24 hours or less shall be considered a single flare event even when the event occurs in two consecutive days. When a flare event continues for more than 24 hours, each calendar day shall be separate flare event.
  4. The owner/operator shall use the staging valve, XV-104, as the on/off flow indicator to determine flare gas flow rate. When XV-104 is open, a maximum flare gas flow rate of 5.9 MMSCFH shall be used for determining emissions. When XV-104 is closed, a flare gas flow rate of 1.2 MMSCFH shall be used. The owner/operator shall continuously record the volumetric flare gas flow rate based on the on/off status of XV-104. Volumetric flow rates of vent gases shall be corrected to standard conditions of 14.7 psia and 68°F.

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5. The on/off status of XV-104, movements of flow control valves PV-2233 and PV-2243 and vessel pressures monitored by PI-1511 and PI-2242 shall be monitored and recorded continuously.
6. If vessel pressure monitored by PI-1511 is greater than 200 psig when a flare event occurs, vent gas combusted by the flare shall be assumed to be natural gas. If vessel pressure monitored by PI-1511 is equal or less than 200 psig when a flare event occurs, vent gas combusted by the flare shall be assumed to be either PSA offgas or Syngas.
7. The owner/operator shall use the flow rate of vent gas determined in accordance to Condition Nos. 4, 5 and 6 and the below emission factors in determining emissions from the flare. Emissions from the flare pilots shall be calculated using a flow rate of 110 SCFH and emission factors for natural gas. Emissions from purge gas shall equal to zero.

Emission Factor	PSA Offgas or Syngas (lb/MMscf)	Natural Gas (lb/MMscf)
ROG	1.26	7
NO <sub>x</sub>	20.54	130
CO	47.16	35
PM <sub>10</sub>	1.35	7.5
SO <sub>x</sub>	0.0	0.83

8. The owner/operator shall purge the flare with nitrogen gas only.
9. Whenever the devices monitoring and recording the on/off status of XV-104, movements of flow control valves PV-2233 and PV-2242 and vessel pressures monitored by PI-1511 and PI-2242 are down due to breakdown or maintenance, the owner/operator shall use the data substitution method referenced in Attachment B of Rule 1118 to calculate and report flare emissions.
10. The owner/operator shall sample and analyze Syngas and PSA Offgas vented to the flare once a year. The analysis shall include the gas composition, high heating values, total sulfur contents of the gases and follow the methods listed in Rule 1118(j). Samples shall be taken within 30 minutes, but no sooner than 15 minutes, of the start of a flare event for the Syngas and PSA offgas vent stream. Based on the test results, the Executive Officer may require the owner/operator to submit an application to modify the emission factors for Syngas and PSA offgas shown in Condition No. 7. Test results shall be included in the quarterly report (see Condition 15) submitted to the AQMD.
11. The owner/operator shall monitor the flares at all times for presence of a pilot flame using a thermocouple that will alarm the owner or operator in the event of a flame out. The owner or operator shall re-ignite the pilot immediately after a pilot flame out occurs.

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12. The owner/operator shall notify the Executive Officer within one hour of any unplanned flare event with emissions exceeding either 100 pounds of VOC or 500 pounds of sulfur dioxide, or exceeding 500,000 standard cubic feet of flared vent gas. The owner/operator shall also notify the Executive Officer by telephone at least 24 hours prior to the start of a planned flare event with emissions exceeding either 100 pounds of VOC or 500 pounds of sulfur dioxide, or 500,000 standard cubic feet of combusted vent gas.
13. The owner/operator shall conduct a Specific Cause Analysis for any flare event, excluding planned shutdown, planned startup and turnaround, resulting in any of the followings: (a) 100 pounds of VOC emissions. (b) 500 pounds of sulfur dioxide emissions. (c) 500,000 standard cubic feet of vent gas combusted. The analysis shall identify the cause and duration of the flare event and describe any mitigation and corrective action taken to prevent recurrence of a similar flare event in the future. Unless an extension is granted, the owner/operator shall submit Specific Cause Analysis to the Executive Officer within 30 days of the event.
14. The owner/operator shall conduct an analysis and determine the relative cause for a flare event that results in combustion of more than 5,000 standard cubic feet of vent gas. A Specific Cause Analysis may be submitted to satisfy this condition.
15. The owner/operator shall maintain records of all the information required to be monitored and make such records available to District personnel upon request.
  - a. Flare event data collected pursuant to paragraphs (g)(3), (g)(4), (g)(5), (g)(6) and (g)(8)(C) of Rule 1118 as applicable.
  - b. Total daily and quarterly emissions of criteria pollutant from flare C4007 and each flare event along with all information specified by Rule 1118(i)(5)(B).
  - c. Monitoring records of closures of control valves and vessel pressures pursuant to Condition Nos. 2 and 4.
  - d. Pilot flame failure report.
  - e. Sample results for gas composition, HHV and TSC pursuant to Condition No. 10.
  - f. Specific Cause Analysis completed pursuant to Condition No. 13.
  - g. Relative Cause Analysis completed pursuant to Condition No. 14.
  - h. Annual acoustical pressure relief device leak survey.
  - i. Video records pursuant to Rule 1118(g)(7).

Within 30 days after the end of each calendar quarter, the owner/operator shall submit a quarterly report to the AQMD Refinery Enforcement Team at the below address. Item (a) through (g) shall be submitted quarterly in electronic format. Hard copy of item (h) shall be submitted with the quarterly report for the quarter which the survey was conducted. Item (i) shall be made available to the Executive Officer upon request.

All records required by this condition shall be certified for accuracy in writing by the responsible facility official and maintained for at least five years.

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16. The owner/operator shall comply with all provisions of this approved Flare Monitoring and Recording Plan unless the plan is suspended, revoked, modified, reissued, or denied. Violation of any of the terms of the plan is a violation of Rule 1118.